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## IMPLEMENTATION OF TWO THRESHOLD GUARD CHANNEL SCHEME IN WIRELESS CELLULAR NETWORKS

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### Abstract:

In cellular wireless networks, resources are constrained. These limited resources must be utilized effectively. There are two categories of voice users in a cellular network: new calls and handoff calls. Handoff calls are prioritized higher than new calls, leading many researchers to investigate methods to block new calls while terminating ongoing calls. Numerous schemes exist, but we have chosen to focus on the two-threshold guard channel scheme in wireless cellular networks and we are going to implement this and observe the results.

Keywords: Cellular wireless network, Two Threshold guard Channel Scheme

### 1. Introduction:

Cellular networks allow our mobile devices to operate anywhere, from city roads to interstate highways. They partition extensive areas into smaller "cells," with each cell governed by a tower that manages a restricted number of radio channels for communication, messaging, and internet connectivity. With billions of users and the swift expansion of 5G, these towers are experiencing substantial pressure, attempting to optimize performance from constrained airwaves that were obtained at a hefty price in auctions.

The calls come in two main types: new calls that start right in your current cell when you hit dial, and handoff calls that kick in as you drive between cells, handing off your chat to the next tower without a hitch. Handoffs get VIP treatment because nothing frustrates users more than a call dropping mid-sentence it's way worse (like 10-100x) than just getting a busy signal on a new call.

That's why experts cook up smart rules to block some new calls and save channels for handoffs. We're zeroing in on the two-threshold guard channel Scheme: it sets  $T_1$  as the max for new calls and  $T_2$  as the safety zone for handoffs. New calls get through up to  $T_1$ , handoffs up to  $T_2$ , and everything stops after that. In this project, we build this model using Markov math to crunch state probabilities and dropping rates for handoffs (Class-1). We'll tweak traffic loads ( $\alpha_m$ ) and new call mixes ( $\alpha_n$ ) to

spot the sweet spots, helping real networks run smoother with happier users. remove the unwanted matter in the introduction and make it in a correct way

## 2.Literature Survey:

U. Arinze et al This study tackles QoS and resource challenges in mobile networks, balancing revenue with low handoff drops and new call blocks. It introduces a smart hybrid approach mixing Deep Reinforcement Learning, Markov processes, and adaptive call controls for real-time voice and non-real-time data traffic. A dynamic threshold flexes resources during peak loads, powered by a learning agent. MATLAB, OMNET++, and SPSS simulations compare the new DQL-AJCAC method against traditional ones. [1]

Sahu, P.K.et al Voice is king in 5G phones won't even connect without it, needing full support from IMS to core to RAN, plus smooth handoffs to older 4G/3G/2G networks. EPS eases 4G-to-5G shifts, CSFB helps 2G/3G-to-4G jumps. To stop drops when users switch cells and find no channels, they propose Optimal Channel Reservation (OCR). Tested on GSM 900, it nails low handoff drops while minimizing new call blocks. [2]

Raja, S.K.S.et al Mobile networks are swamped with more users but stuck with limited bandwidth, so smart resource management is a must during peak traffic and user movement. Call Admission Control (CAC) is key—it lets in more calls without tanking quality for active ones. This survey breaks down CAC strategies, sorts them by research, covers design tips and real-world setups. It wraps up with big challenges ahead for next-gen wireless tech. [3]

Kulshrestha, et al This paper introduces a smart fractional guard channel system to make the most of scarce radio airwaves, adding buffers to favor strong-signal handoff calls over weak ones. They built two models and crunched the math for blocking rates, handoff drops, channel use, and buffer efficiency in cell networks. Simulations show how tweaking parameters impacts the main performance stats. [4]

P Biradar, et al This work dives into a fresh Call Admission Control setup for smooth handoffs and smart new call blocking as mobile traffic explodes. With cells shrinking to keep up with demand, nailing handoffs is make-or-break. They break down various schemes for mixed traffic and simulate an ATM wireless network using bandwidth tweaks plus dynamic guard channels. [5]

Ojesanmi et al. (2021) came up with a smart adaptive guard channel scheme for mobile networks that tweaks the number of reserved channels on the fly, cutting down both new-call blocking and handoff drops way better than old-school fixed guard setups. [6]

Adediran et al. (2021) designed a flexible handoff prioritization mechanism that combines guard channels with a shared central pool, so that handoff calls receive strong protection before being dropped. However, the scheme relies on a shared-pool architecture rather than a clear two-threshold model, and the signaling overhead and scalability issues in dense deployments are not fully investigated. [7]

K. Singh et al. (2025) analyzed the behavior of conventional guard channel and fractional guard channel schemes under increasing traffic loads, showing that fractional or threshold-based reservation provides better handoff protection while controlling new-call blocking. Their work, though, is mostly confined to simplified single-cell settings and does not implement or evaluate a concrete two-threshold guard policy with distinct limits for new and handoff calls. [8]

Sharma et al. (2021) presented a survey of handover management techniques in cellular systems and emphasized that guard channel reservation is an effective way to reduce handoff drops at the cost of higher new-call blocking. Being a survey, the study remains conceptual and does not propose or experimentally validate a specific two-threshold guard channel algorithm. [9]

Verma et al. (2025) used simulation to compare several guard-type reservation strategies and quantified their trade-offs between handoff dropping probability and new-call blocking in modern

cellular environments. Nonetheless, their analysis gives limited attention to heterogeneous multi-RAT (4G/5G) deployments, and the problem of adaptively or intelligently tuning two separate thresholds is identified as an open issue for future research. [10]

### 3. TWO-THRESHOLD GUARD CHANNEL POLICY

Two thresholds are used by our system to control traffic:  $T_1$  for new calls and  $T_2$  for high-priority handoff calls (where  $T_1 < T_2 \leq C$ ). The system operates with a total of  $C$  channels. When a call is received, the controller determines the type of call,  $c(t)$ , and the number of channels that are currently in use... If all channels are busy, we simply reject the call. Handoff calls get preferential treatment—they're accepted as long as  $c(t) < T_2$  because dropping an active call frustrates users more than blocking a new one. New calls face tighter restrictions and only get through when  $c(t) < T_1$ . This means the space between  $T_1$  and  $T_2$  acts as a buffer zone reserved mainly for handoffs. We built this using a straightforward function called `admit call(call type, c_t, C, T1, T2)`. Users can configure  $C$ ,  $T_1$ , and  $T_2$  when they run the program, which makes it easy to experiment with different settings and compare how well this approach performs against other admission policies.

#### Algorithm:

```
if (NEW CALL) then
if ( c (t) < T1 ) then
accept call
else
reject call
end if
end if
```

```
if (HANDOFF CALL OF
CALL 1) then
if (c(t) < T2 ) then
accept call
else
reject call
end if
end if
```

```
if (HANDOFF CALL OF
CALL 2) then
if (c(t)< C ) then
accept call
else
reject call
end if
end if
[11]
```

#### 3.1 Computation of Class-1 Handoff Accept/Drop Probabilities:

Using the developed Python model, we analytically evaluate a two-threshold guard channel call admission scheme with probabilistic access in the intermediate region. The considered cell has  $C = 100$  channels and two thresholds,  $T_1 = 80$  and  $T_2 = 95$ , which partition the system into three operating regions: an ordinary shared region  $[0, T_1)$ , a fractional region  $[T_1, T_2)$  where access probabilities are scaled by a factor  $\alpha$ , and a high-priority region  $[T_2, C]$  governed by a more restrictive factor  $\alpha_2 = 0.2$ . For a given offered load  $\rho$ , the steady-state probability of having  $n$  occupied channels is obtained in closed form by splitting the normalisation constant into three sums that correspond to these regions and then computing  $P(n)$  piecewise, which follows the standard birth-death formulation used in finite-population fractional guard channel models. On top of this state distribution, the Class-1 handoff performance is characterised via the handoff dropping probability  $B_{h1} = \sum_{n=T_2}^C P(n)$  and the corresponding acceptance probability  $A_{h1} = 1 - B_{h1}$ , which directly capture the trade-off between reserving capacity for protected calls and utilising channels efficiently. By sweeping the load parameter  $\rho$  through  $\alpha_m$  (via  $\rho = \alpha_m/\mu$ ) and, separately, varying the fractional factor  $\alpha$  through  $\alpha_n$ , the code generates tables of  $A_{h1}$  and  $B_{h1}$  similar to those typically used to compare classical guard-channel and limited-fractional guard-channel policies in the literature. This numerical framework thus allows us to systematically study how the two thresholds and fractional parameters influence handoff dropping and acceptance probabilities and to tune the scheme under given QoS constraints.

### 4. Results/Graphs:

To evaluate the proposed two-threshold fractional guard channel scheme, we generate four sets of curves that highlight the trade-off between new call blocking and handoff dropping under different

traffic conditions.

**Figure1 :**First, we plot the handoff call acceptance probability against the new call blocking probability as the macrocell load parameter  $\alpha_m$  increases from 1 to 10. This curve clearly shows that, under light load, handoff calls are almost always accepted and new calls experience negligible blocking. As  $\alpha_m$  grows and the cell approaches its effective capacity, the handoff acceptance probability gradually decreases, while the new call blocking probability increases, indicating that the scheme preferentially protects ongoing handoff calls by restricting access for new calls when resources become scarce.

**Figure 2:**The second plot shows the handoff call dropping probability as a function of the new call acceptance probability. Here we observe that, for moderate values of  $\alpha_m$ , both metrics remain in a desirable range: new calls are still admitted with high probability and handoff dropping remains very low. However, once the load crosses a certain point, a small decrease in new call acceptance corresponds to a noticeable increase in handoff drops, making this curve a useful tool for identifying operating regions where the quality of service for ongoing calls starts to degrade.

**Figure 3:**In the third graph, we directly relate handoff acceptance to handoff dropping. The points start near the ideal corner (high acceptance, almost zero dropping) and gradually move toward higher dropping probabilities as the system is driven into heavier load conditions. This plot makes it easy to see how much handoff protection is actually delivered by the chosen threshold and fractional parameters, and where the guard band begins to saturate.

**Figure 4:**Finally, we plot new call acceptance versus new call blocking. The curve remains near the ideal region at low values of  $\alpha_m$ , with almost all new calls being accepted. As traffic increases, the acceptance probability collapses and blocking approaches one, capturing the intuitive behaviour that new call attempts are progressively sacrificed to preserve capacity for ongoing handoff calls. Together, these four graphs provide a clear, visual summary of how the proposed scheme balances accessibility for new users against continuity for existing connections over the examined range of  $\alpha_m$  and  $\alpha_n$ .

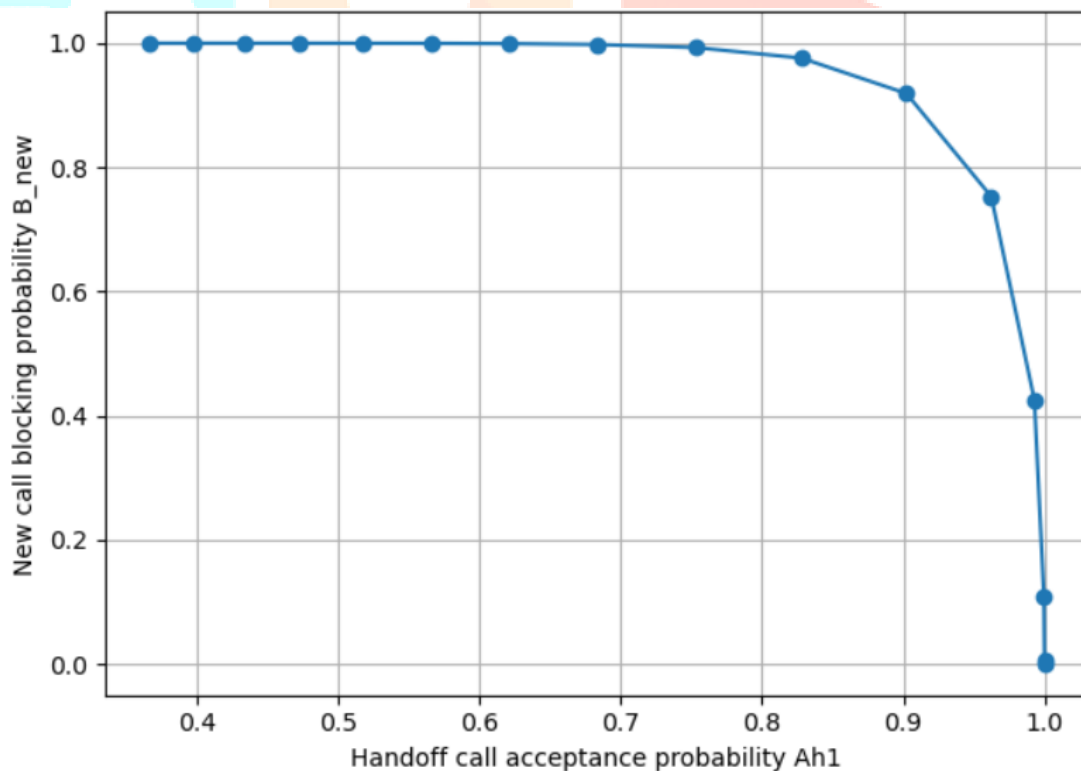


Figure 1:New call Blocking Probability vs Handoff call Acceptance Probability

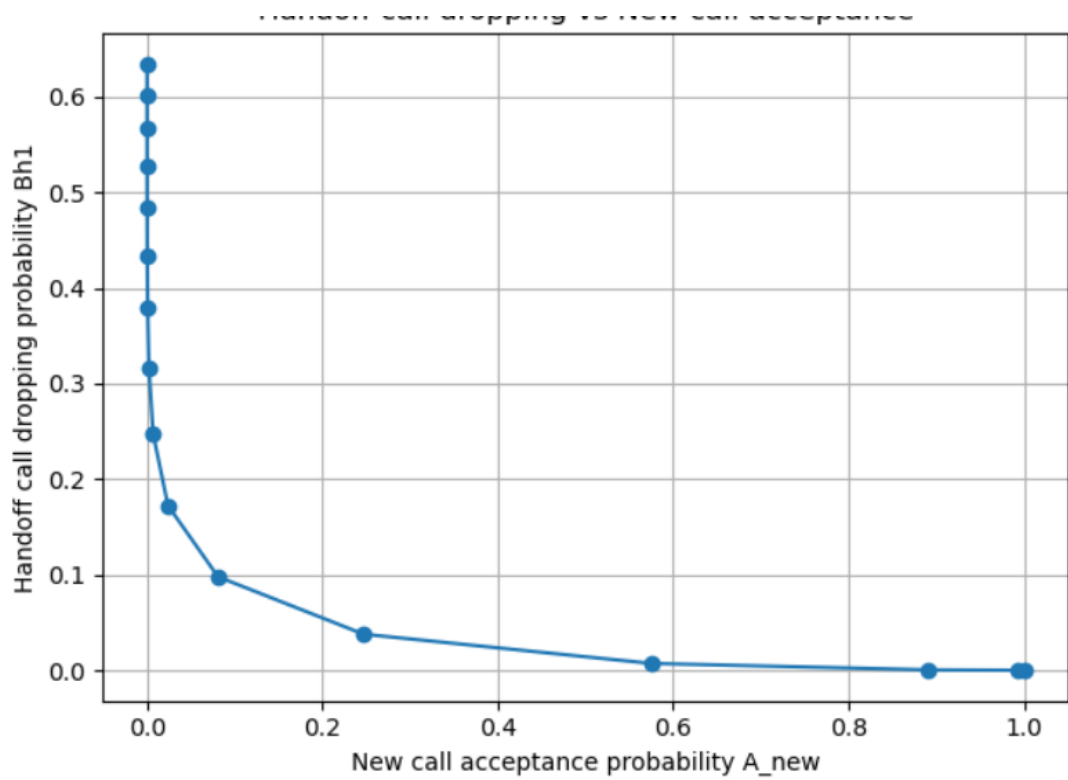


Figure 2: New call acceptance probability Vs Handoff call dropping probability

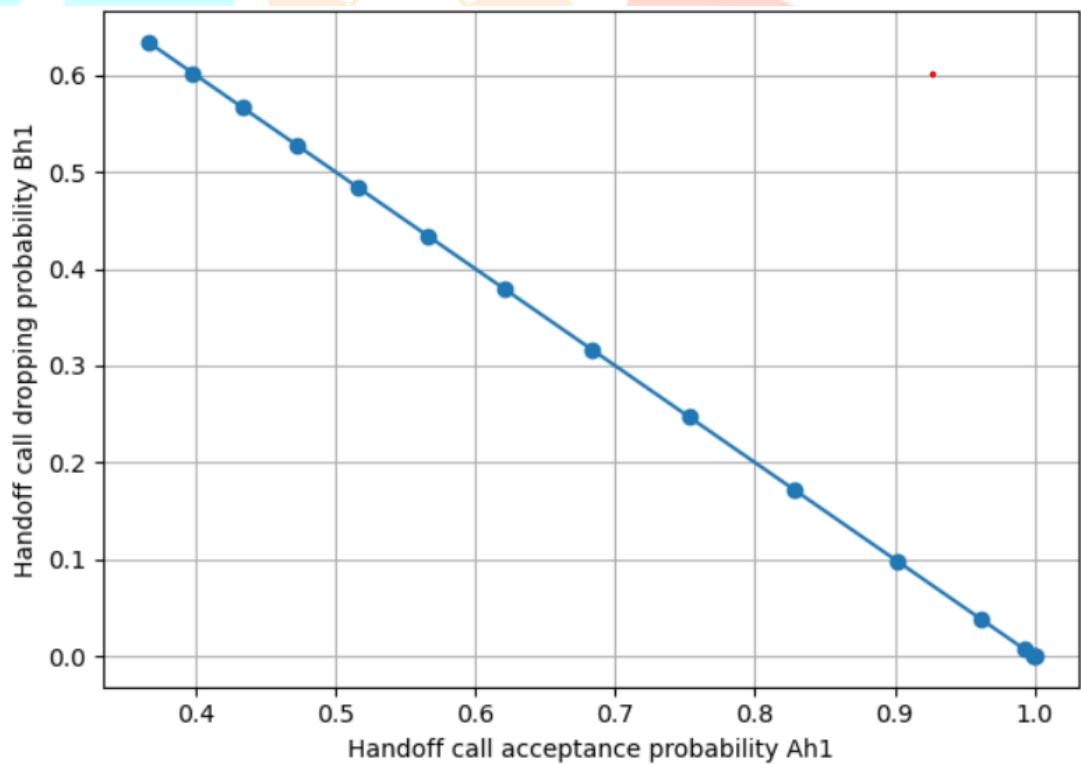


Figure 3: Handoff call acceptance Probability vs Handoff call dropping probability

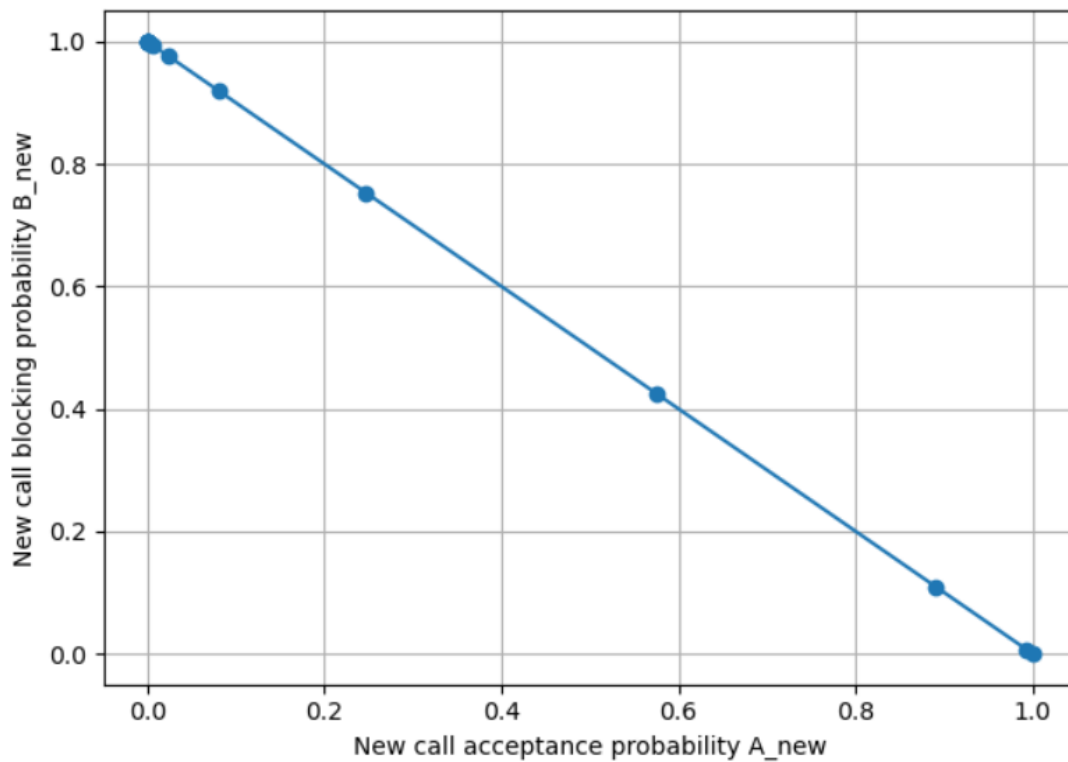


Figure 4: New call acceptance Probability vs New call blocking probability

## 5. Conclusion:

This work developed and evaluated a simple two-threshold guard channel scheme that prioritizes handoff calls while keeping the model and implementation lightweight. The cell is partitioned by two thresholds  $(T1)$  and  $(T2)$  into an open region for new and handoff calls, an intermediate band controlled by fractional parameters, and a final guard region reserved mainly for protecting ongoing handoff connections. Using a compact analytical formulation and a short Python implementation, we computed the steady-state state probabilities and derived Class-1 handoff acceptance and dropping probabilities for different values of the load parameter  $(\alpha_m)$  and the fractional factor  $(\alpha_n)$ . The numerical curves show that increasing  $(\alpha_m)$  (heavier offered load) quickly pushes the system into a high-dropping regime, whereas varying  $(\alpha_n)$  over a moderate range produces only fine-tuning of the dropping probability, which suggests that load control is more critical than small changes in fractional access. These results support the general conclusion from previous guard and fractional guard channel studies: with properly chosen thresholds and fractional parameters, it is possible to keep handoff dropping probability within a strict QoS target while still achieving efficient channel utilization and acceptable new-call blocking.

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